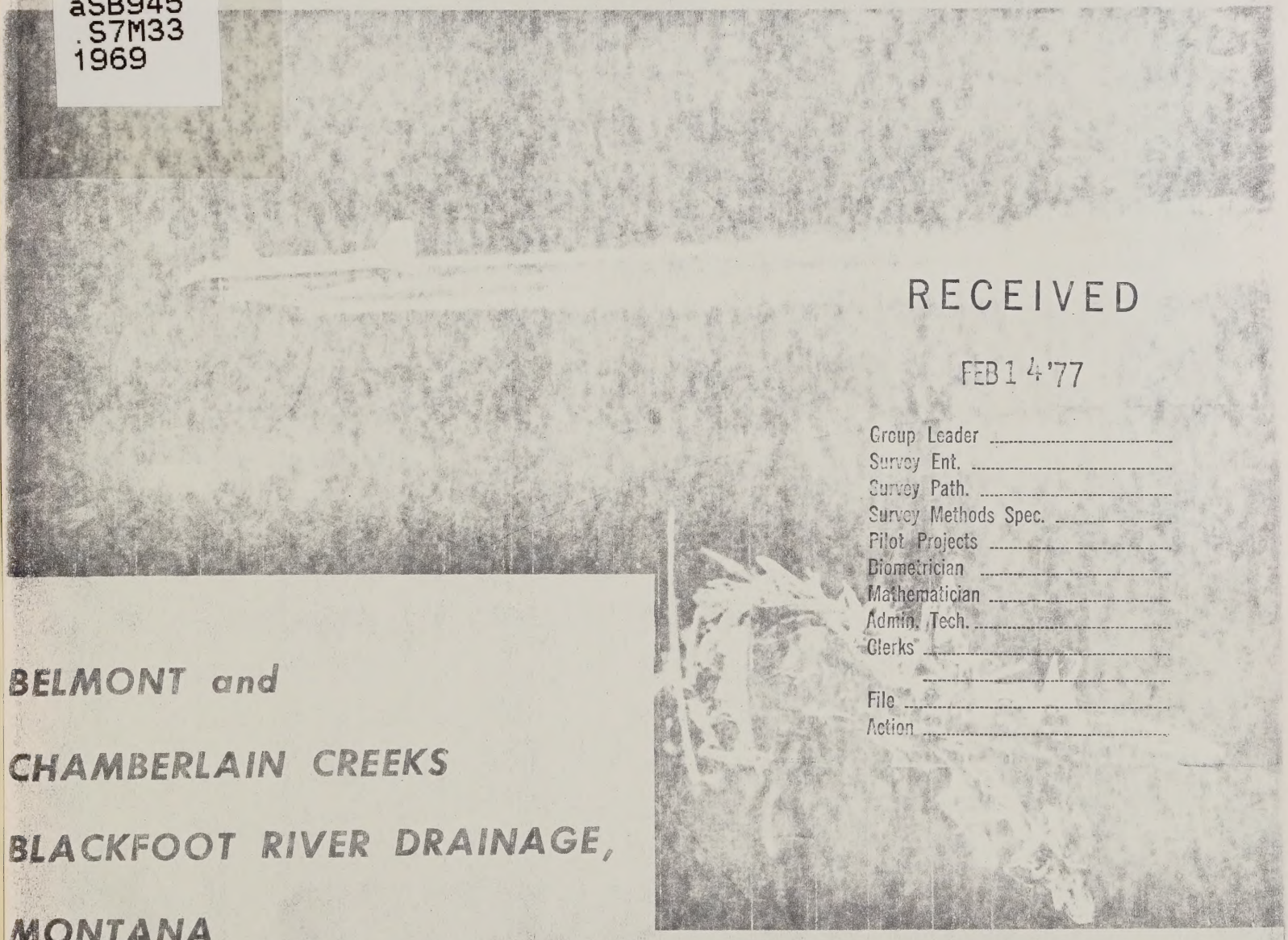
ZECTRAN PILOT TEST TO CONTROL SPRUCE BUDWORM



BELMONT and CHAMBERLAIN CREEKS BLACKFOOT RIVER DRAINAGE, MONTANA

1968

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ZECTRAN PILOT TEST TO CONTROL SPRUCE BUDWORM IN BELMONT AND CHAMBERLAIN CREEKS, BLACKFOOT RIVER DRAINAGE, MONTANA

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ABSTRACT

During 1968, a pilot test was conducted against the spruce budworm in Belmont and Chamberlain Creeks in the Blackfoot River drainage east of Missoula, Montana (fig. 1). Zectran, a nonpersistent carbamate insecticide, was applied at the rate of 1 ounce (6 percent by volume) in 1 pint of Dowanol (carrier), at a droplet size no larger than 120 microns in size per acre.

Spruce budworm mortality was 70.0 ± 4.2 percent in the Burnt Fork of Belmont Creek, and 47.8 ± 5.5 percent in Chamberlain Creek.

INTRODUCTION

The spruce budworm, Choristoneura fumiferana (Clem.), has defoliated Douglas-fir, spruce, larch, and true firs for over 16 years in the Blackfoot River drainage in Montana. Tree mortality has been associated with these outbreaks in some areas. Douglas-fir, larch, and Engelmann spruce are major tree species utilized by the timber industry in the Blackfoot River and the surrounding Lolo National Forest. Therefore, continued growth loss and tree mortality cannot be tolerated.

Chemical control by aerial spraying has been necessary and effective in some areas of the Region in past years. Reinfestation has required some areas to be resprayed. Because of partial success and public concern towards the use of persistent chemicals, research has been reoriented to develop a safer, nonpersistent chemical for use against forest insects--the first test insect being the spruce budworm.

The Insecticide Evaluation Project (IEP), Pacific Southwest Forest and Range Experiment Station, U.S. Forest Service, Berkeley, California, has been field and laboratory testing a carbamate insecticide called Zectran (4-dimethylamino-3,5xylyl methylcarbamate) since 1964.

Zectran has been researched for its possible effects upon birds, small mammals, fish, and aquatic insects. Definite direct effects have not been found to date at the concentrations tested by the U.S. Forest Service. It is the most toxic, nonpersistent chemical tested against spruce budworm to date.

Past pilot projects have tested methods and procedures of application, dosages of Zectran, and spray droplet size. A 1967 test in the Sawtooth National Forest,

Idaho, had two objectives: (1) to test the effectiveness of Zectran against the spruce budworm when applied at the rate of 1 ounce actual per 1 pint of a TPM per acre in droplets not to exceed 50 microns in size, and (2) to determine the practicality of relying on atmospheric transport and dispersion to distribute the small spray droplets to the target. Due to a drastic reduction in the budworm population from natural factors, and problems related to development of a spray system to deliver the spray at expected droplet size, the test was reduced from 60,000 acres to about 2,500 and the rate of application was doubled to compensate for loss of the active ingredient in larger droplets. The objectives of this test were not fully met. Therefore, a test was planned for 1968 with the following objectives:

1. To determine if 1 ounce of Zectran (6 percent by volume) in 1 pint of Dowanol TPM (tripropylene glycol methyl ether) (carrier) applied per acre, is ready for operational use.

2. To test the Freon system developed to produce aerosol size droplets.

INFORMATION AND EDUCATION

Family meetings were presented to Forest Service Regional Office personnel to acquaint them with the purpose of the test. A seminar was presented at the University of Montana on April 15. During May, June, and July, news items were released by the Division of I&E, Regional Office; and the Lolo National Forest. Several feature stories with pictures appeared in The Missoulian, Missoula, Montana. A letter explaining the project, a fact sheet about Zectran, and maps of the test areas were sent to all cooperators, landowners within spray areas, and to Montana's four-man Congressional delegation.

TEST AREAS

Two areas were selected in early spring with the following criteria in mind: (1) heavy budworm populations, and (2) whole drainages, with natural boundaries on three sides. One was 2,912 acres in the Burnt Fork of Belmont Creek; the other was 3,168 acres south of Blacktail Mountain in Chamberlain Creek, both in the Blackfoot River drainage east of Missoula, Montana. Land in the test areas is owned by Anaconda Corporation, Northern Pacific Railroad, State of Montana, Bureau of Land Management, two private landowners, and the U.S. Forest Service. Elevation of plots ranged from 3,500 to 5,200 feet in Chamberlain Creek, and 4,100 to 5,300 feet in Belmont Creek.

OPERATIONAL PHASES

FORMULATION AND APPLICATION

One ounce of Zectran mixed with TPM was applied at the rate of 1 pint per acre.

Mixing and loading was conducted at the fire retardant dock at the Smokejumper Center, Northern Forest Fire Laboratory, Missoula, Montana. Missoula Equipment

Development Center (MEDC) personnel, assisted by two project checkers, loaded the chemical and Freon. A few days prior to spraying, stockmen were notified when spraying would begin.

A Forest Service Cessna 185 airplane equipped with a smoke generator was used to determine the aerial transport of smoke within the spray areas, and optimum spray time. Smoke drift gives an indication of the aerial transport of the very small spray droplets. Smoke was released from the smoke plane to direct each spray run.

A Forest Service C-47 airplane from Region 4 was used for spraying.

DESCRIPTION OF SPRAY SYSTEM

The spray system to produce droplets approaching 50 microns MMD,[1/] and designed for a C-47 aircraft, was developed by MEDC.

The main tank holds 700 gallons (fig. 2). Total boom length is 65 feet, with 237 nozzles at 3-inch intervals (fig. 3).

The tank was loaded with 230 pounds of Zectran in a solution of 406 gallons of Dowanol and 294 gallons of Freon (a common refrigerant gas, Dichlorodiflouromethane). Vapor pressure of the Freon was 60 psi. Nitrogen was introduced to maintain the pressure at 75 psi. When the solution enters the expansion chamber of the nozzle, the Freon expands rapidly, exploding the insecticide into a fine "aerosol mist," with a maximum droplet size of 120 microns when released from the plane. There is no other system known which will produce droplets of this size at a high flow rate. Handling characteristics of the airplane are not adversely affected. At 6,000 feet the fully loaded airplane can maintain altitude with 75 percent power on one engine.

AQUATIC SURVEILLANCE

Sample sites were located near the lower spray boundaries in both test areas. Spray applications were made without regard to fishing streams; i.e., no protective swaths were left unsprayed adjacent to streams.

Surveillance was limited to tests for immediate toxicity to aquatic insects. Drift net samples were collected hourly for 5-minute periods from 0500 to 1800 on the day prior to spraying and on the day spraying took place. Each sample was analyzed by counting the number of insects in each taxonomic order.

Surveillance results indicate no real difference occurred in number of drifting insects for prespray and spray day samples in Chamberlain Creek. However, a small increase in number of Trichoptera did occur in Belmont Creek. The pattern of drift increases suggests the possibility of a slight toxic effect for this one order.

1/ Mass median diameter.

In the event further Zectran projects are planned, it is recommended that aquatic surveillance work be continued to verify these findings.

SAFETY

Many of the safety problems involving contract equipment and personnel were eliminated since only Forest Service pilots and planes were used. Protective gloves, clothing, and masks were worn by those handling the Zectran.

There were no accidents or injuries during the project.

COMMUNICATIONS

Two air-net radios were obtained from the Division of Fire Control to relay current weather conditions from the spray areas to the smoke plane to the loading dock.

ENTOMOLOGICAL PHASE

DEVELOPMENT SAMPLING

Development sampling began June 26, approximately 2 weeks after the larvae had broken hibernation. Samples were collected from each area every other day. A sample consisted of 1,000 larvae, 100 each from all crown levels and age classes of Douglas-fir from 10 sites. Sample trees were representative of elevation, exposure, stand age, and density in each area. Samples were separated into instars by visual observation in the field at the time of collection.

Development sampling continued through July 9 in Chamberlain Creek, and July 11 in Belmont Creek, at which times the areas were released for spraying. Due to rain and wind, Chamberlain Creek was not sprayed until July 11, and Belmont Creek July 15.

Larval development was slow through June and early July due to cool, rainy weather, but then progressed rapidly during the second week in July. The budworm population varied as much as four instars between high and low elevations in the spray blocks, but was nearly equal on spray day. The majority of budworm at lower elevations were fifth and sixth instars when the areas were released for spraying. Less than 1 percent of the budworm on Douglas-fir were pupae when Belmont Creek was sprayed. IEP indicated a larger percent of the population was pupae on Engelmann spruce and subalpine fir. The percent of larval population by instar at spray day is given in table 1.

Table 1.--Percent of budworm by larval instar at spray date

Creek	Instar 3d	4th	5th	6th	Pupae
Chamberlain	3	27	45	25	0
Belmont	1	30	49	20	1

PRESPRAY SAMPLING

Prespray samples were collected 2 or 3 days prior to spraying. Samples came from 40 Douglas-fir single tree plots scattered throughout the area. Samples were collected at midcrown with a pole pruner equipped with an attached bag. Four 15-inch branches were taken from each plot for a total of 160 samples per area. Number of buds and budworm were counted; and the width and length of each branch was measured in the laboratory by women.

POSTSPRAY SAMPLING

Postspray samples were taken 4 days after an area was sprayed. Sixteen 15-inch branches were collected from the same 40 sample trees, giving a total of 640 samples per area. These samples were checked the same as the prespray samples.

RESULTS

All data were sent to the Insecticide Evaluation Project, Pacific Southwest Forest and Range Experiment Station, Berkeley, California, for analysis. Insect mortality was calculated by two methods: (1) bud-based mortality (a correlation between buds and number of budworm), and (2) area-based mortality (a correlation between branch surface area and number of budworm). The final percent mortality is a composite of the two methods.

Data analysis showed that the budworm population was reduced 47.8 ± 5.5 in Chamberlain Creek and 70.0 ± 4.2 in Belmont Creek. This does not give any indication as to what amount of the mortality was due to natural causes or to Zectran. The amount of spray material that reached the ground was not measured. An IEP check area 20 miles west of Chamberlain Creek and 12 miles south of Belmont Creek near Coloma had a population reduction from natural factors of 32.5 ± 9.8 for the same period of time.

DISCUSSION

The reason for low mortality in Chamberlain Creek isn't completely understood. Climatic conditions are probably responsible for part of this. The conditions under which Chamberlain Creek was sprayed were apparently ideal as far as relying on a proper inversion to disperse the spray into the area. Without a proper inversion, much of the spray may never reach the ground. Observations the days of spraying indicated that much of the spray never reached understory trees (15 to 20 feet high), let alone ground level. Many live budworm were found on reproduction in late afternoon the day of spraying and through the postspray sample. MEDC indicates droplet sizes were no larger than 120 microns MMD in tests prior to spraying. Methods are not available for measuring smaller droplets. Since the average drop size is not known, and drop dispersion was not traced in the area, the amount of material that actually reached the ground is not known. Better methods of tracing spray droplets and of determining droplet size are needed.

Past pilot tests using Zectran have shown that the largest droplets found on dead insects were in the vicinity of 107 microns. Thus, mortality is probably achieved with the smaller droplets. When using ultra-low volume application or with droplets of 120 microns or less, air currents play a major role in insecticide coverage. Atmospheric transport and diffusion were expected to assist in spray dispersion. However, this apparently did not occur. Additional knowledge of these conditions and of wind movement is especially important in determining the optimum height and location of spray runs to take fullest advantage of atmospheric transport and dispersion of the spray to the insect.

IEP showed budworm mortality by natural factors was 32.5 ± 9.8 in Coloma; however, Coloma does not represent either spray area as to exposure, elevation, or budworm population, but may be partially representative as to natural population reduction. In future tests an effort should be made to assess percent mortality attributed to parasites, etc. Perhaps less than 100 percent mortality is satisfactory, but until the population dynamics of the target pest are understood, the percent survival that can be tolerated cannot be determined, nor can we determine whether natural factors will check the remaining population.

The apparent poor mortality observed in Chamberlain Creek during and after spraying resulted in reducing the number of nozzles on the spray plane by half prior to spraying Belmont Creek. This gave half the flow rate, and required twice as many spray runs. This resulted in overlapping, especially at the lower end of the drainage. The differences in application, coupled with a light intermittent rain and some wind, probably had an indirect effect upon mortality. Mortality in Belmont Creek was probably increased by cutting the flow rate and making twice as many spray runs.

The results of this pilot test were not encouraging. Based on this year's findings, we do not recommend Zectran for operational use under the present application procedures or at the dosage tested.

To rely on inversions to properly disperse the spray when the insect is most susceptible would seem to be impractical on an operational basis, in this area, due to unpredictable climatic conditions.

PROJECT PERSONNEL

Project Supervisor	Mark D. McGregor	I&D Branch, S&PF, RO
Project Entomologist	Jerald E. Dewey	I&D Branch, S&PF, RO
Airbase Supervisor	Frank A. Borgenson	Div. of Fire Control, RO
Pilot	James Larkin	Region 4
Administrative Assistant	Shirley Schroeder	Div. of S&PF, RO
Loaders	Al Belusci,	MEDC
	John Cavill	MEDC
Biological Checkers	Hubert E. Meyer,	I&D Branch, S&PF, RO
	5 men	Lolo NF
Counters	5 women	Missoula, Montana

PRINCIPAL INVESTIGATORS AND COOPERATIVE AGENCIES

Aquatic Surveillance

Fisheries Biologist	Chuck Whitt	Div. Range and Wildlife, RO
Biological Aid	Keith King	I&D Branch, S&PF, RO

INSECTICIDE EVALUATION PROJECT, PSW, BERKELEY, CALIFORNIA

Project Leader	Dr. Arthur Moore
Entomologists	George Downing
	Dr. Carroll Williams
	Patrick Shea

MISSOULA EQUIPMENT DEVELOPMENT CENTER

Test Section	Arthur J. Mattila
Mechanical Engineers	Anthony E. Jasumback,
	Al Belusci
Mechanical Engineering Technician	John Cavill

ZECTRAN PROJECT COSTS - F.Y. 1968-69

	804		904
Aircraft			
Region 4 (C-47)			600.00
Aerial - July 1			45.32
Aerial - Testing smoke generator			133.63
Smoke tests	16.47		512.39
Total aircraft	16.47		1,291.34
Insecticides and Chemicals			
Freon gas	2,500.00		
Nitrogen	138.68	(est.)	
Total chemicals	2,638.68		
Personnel			
Salaries - Fire Control pilots			306.30
Salaries - Keith King (June 10 - July 16)	321.60		493.73
Salaries - Lolo NF	332.98		2,094.42
Salaries - Checkers	289.90		974.31
Per diem			6.00
Total personnel	944.48		3,874.76
Miscellaneous			
Mileage	258.72		678.26
Shipment of Zectran, R-1 to R-4	260.02		
Shipment of smoke generator, R-4 to R-1	5.30		
Carvusoil	33.25		
Paper bags	33.20		
Protective clothing			72.55
Cold storage	15.00		
Install and remove smoke generator in plane	95.12		
Total miscellaneous	700.61		750.81
Total Costs	$4,350.24		$5,916.91
GRAND TOTAL		$10,267.15	

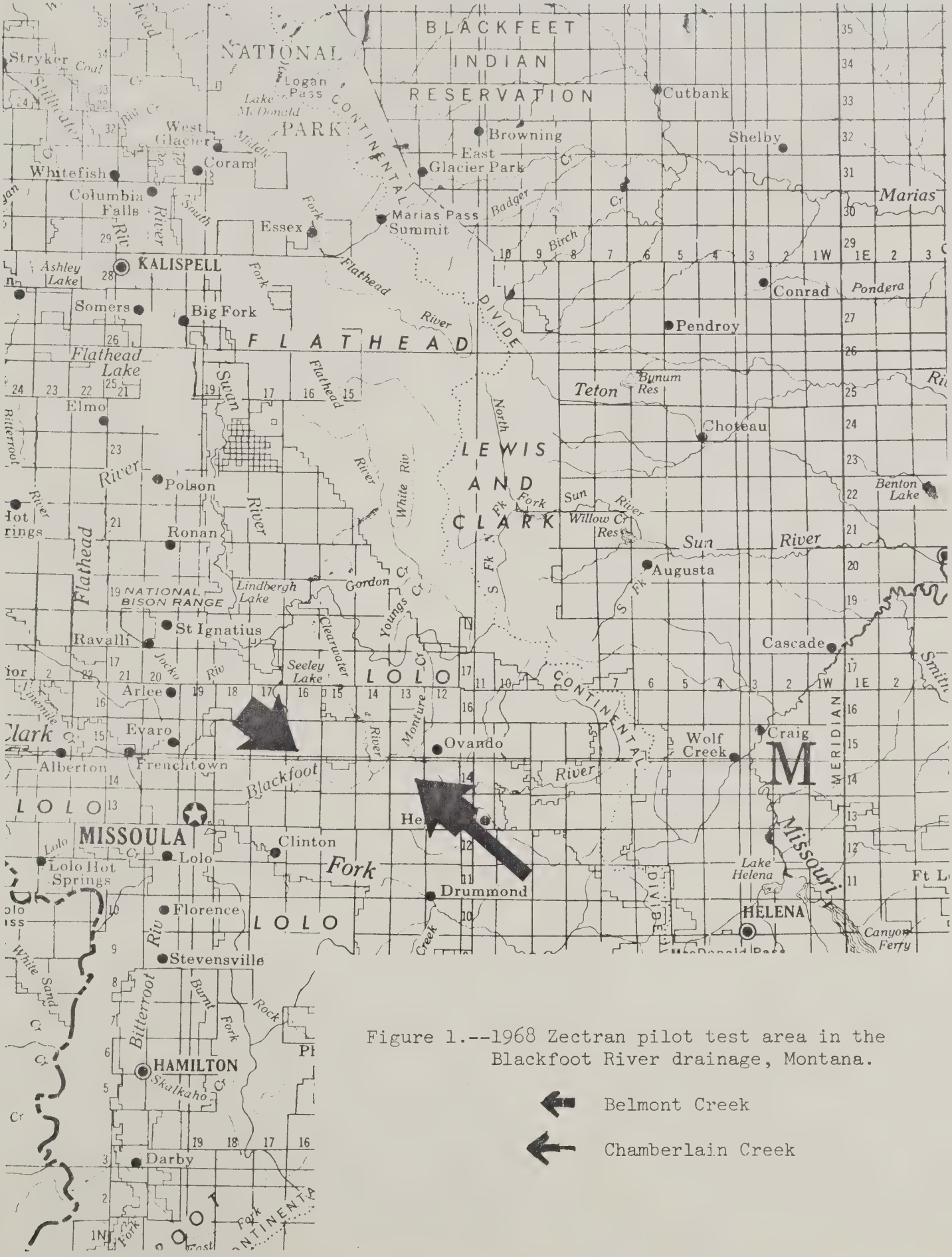

Figure 1.--1968 Zectran pilot test area in the Blackfoot River drainage, Montana.

Belmont Creek

Chamberlain Creek

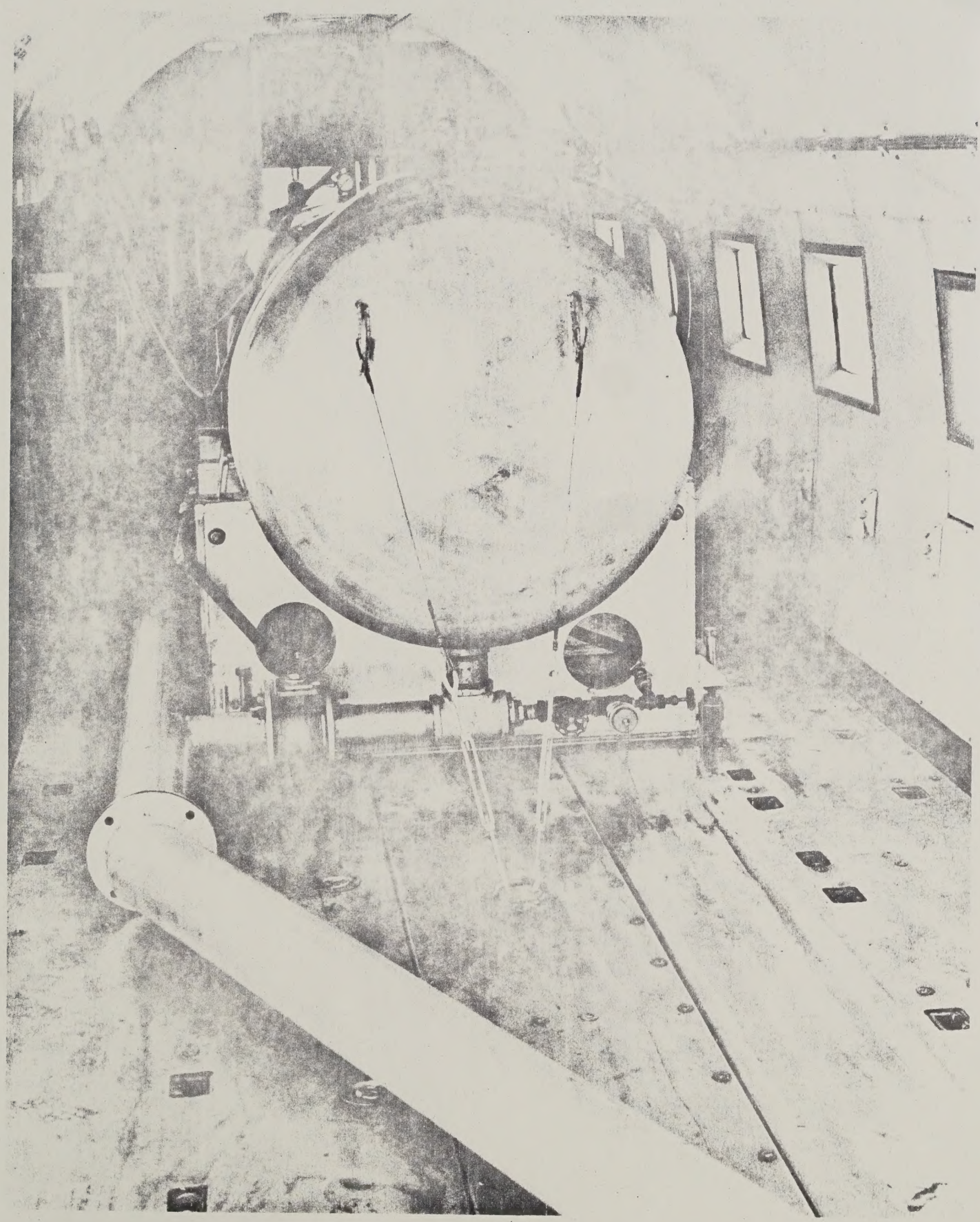

Figure 2.--Rear of tank installed in C-47. (Photo by MEDC.)

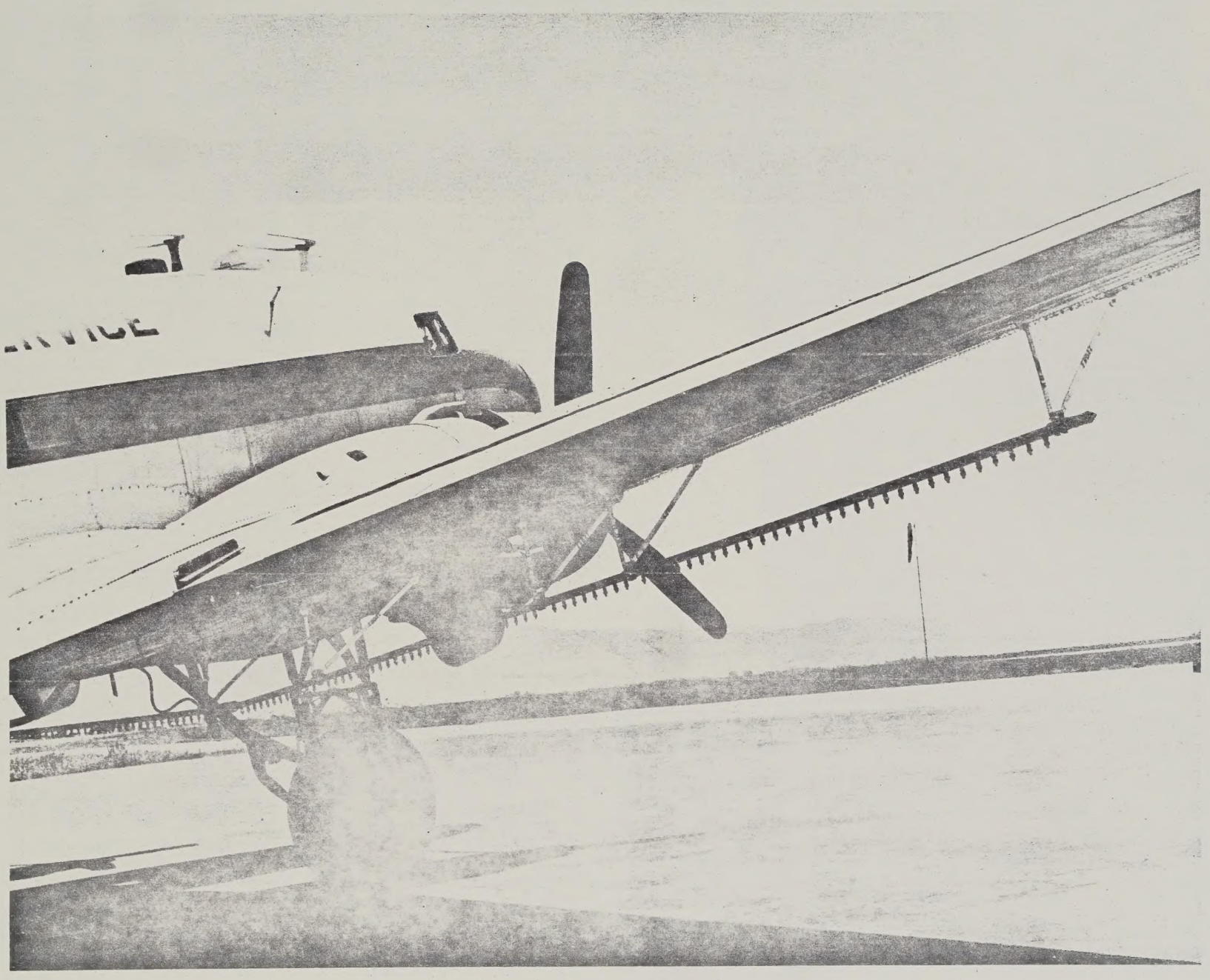

Figure 3.--View of boom and nozzle arrangement on C-47. (Photo by MEDC.)